Iron Status of Newborns Born to Iron Deficient Anaemic Mothers

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Summary

Haemoglobin, serum iron, total iron binding capacity, and serum ferritin were determined in newborns of 16 mothers with iron deficiency anaemia, 28 mothers with non-anaemic iron deficiency, and nine mothers with normal haemoglobin and serum ferritin levels.

The results showed that there were no significant differences in the mean values of haemoglobin, serum iron, and total iron binding capacity among the newborns in the three groups. However, the mean value of serum ferritin differed significantly among the three groups, with the lowest values found in newborns of mothers with iron deficiency anaemia.

Introduction

Anaemia is the most common complication of pregnancy. The prevalence of anaemia in pregnant women is about 20–30 per cent in Japan. Most of them are considered to be mild iron deficiency anaemia and thus do not influence the fetus iron status. Iron is acquired by the fetus in utero in constant proportion to normal increases in body size, and that cord blood haemoglobin level is similar in both anaemic and non-anaemic mothers.

With regard to serum ferritin, several studies reported from developed countries have shown that there is little correlation between maternal and newborns' ferritin concentrations.1-2 On the other hand, it has been reported that newborns' serum ferritin concentration appeared to be lower when the maternal ferritin concentration is less than 10 ng/ml.3 These studies suggest that the fetal iron stores are reduced in iron depleted mothers compared to that in iron repleted mothers.

Although the iron transfer from the mothers to the foetus occurs against a concentration gradient, maternal iron is the only source of fetal iron during pregnancy. Therefore, it is logical to speculate that the maternal iron deficiency with or without anaemia may compromise the iron stores of newborns.

The purpose of this study is to evaluate the iron stores of newborns of mothers with iron deficiency anaemia and non-anaemic iron deficiency, as determined by cord blood serum ferritin.

Subjects

Fifty-three healthy mothers attending the Itokazu Hospital (age range 17–35 years, each had between one and three pregnancies) in labour and their full-term newborns with no prenatal or perinatal complications were recruited for the study. Those with birth weights > 2500 g, were selected as subjects. Fifty-three mothers were divided into three groups according to their predelivery haemoglobin and serum ferritin concentrations as follows:

1. IDA = iron deficiency anaemia with haemoglobin concentrations < 11.0 g/dl and serum ferritin concentrations < 7.1 ng/ml (mean-2SD of healthy adult women4 were considered as the cut-off value of iron depleted).
2. NIDA = non-anaemic iron deficiency with haemoglobin concentrations > 11.0 g/dl and serum ferritin concentrations ≤ 7.1 ng/ml (mean-2SD of healthy adult women4 were considered as the cut-off value of iron depleted).
3. NC = non-anaemic and non-iron depleted mother with haemoglobin concentrations > 11.0 g/dl and serum ferritin concentrations > 7.1 ng/ml were selected as normal control (NC).

Acknowledgements

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haemoglobin, serum iron, total iron-binding capacity, and ferritin.

Maternal and paired cord blood haemoglobin (Hb) values were determined by the cyanmethohaemoglobin method. Serum iron was measured by Nitroso-PSAP method. Serum total iron binding capacity was determined by ion-exchange resin method using Amberlite CG-400 as adsorbent (KAINOS Laboratories, INC). Serum ferritin was determined by the duplicated enzyme immunoassay method (MITUI).

The mean values for the results in the three groups were compared by analysis of variance, and the rate of multipera or iron supplementation were compared by Chi-squared test.

All statistical analysis was conducted after log transformation of ferritin values since only log ferritin has been shown to have a normal distribution.

Results

The number of mothers in each group, their ages and characteristics were shown in Table 1. Mother's age was similar among the three groups. The rate of multipara or mother who had therapeutic iron supplementation during pregnancy were not significantly different among the three groups.

Parameters of iron status in newborns of three groups are shown in Table 2.

Significant differences were not found in mean values of haemoglobin, serum iron and total iron binding capacity among the three groups. However, mean value of serum ferritin differed significantly among the three groups, with the lowest values found in neonates born to mothers with iron deficiency anaemia.

Discussion

In Japan prophylactic iron supplementation for pregnant women is uncommon. However, most mothers with anaemia receive therapeutic iron supplementation during pregnancy. The mean values of maternal haemoglobin in the IDA group of our study was 10.3 g/dl which indicated mild iron deficiency anaemia. It has been thought that such mild anaemia does not influence the haemoglobin and iron concentrations of the newborns as iron transfer from maternal to fetal compartment occurs against a concentration gradient. For this reason most clinicians have not been particularly concerned about the maternal iron status in the absence of significant iron deficiency anaemia in spite of the high prevalence of iron deficiency anaemia in infants. The results of the present study also show that the levels of haemoglobin, serum iron, and total iron-binding capacity were not significantly different among the three groups.

### Table 1

<table>
<thead>
<tr>
<th>Group</th>
<th>No.</th>
<th>Mother's age (years)</th>
<th>Multipara* n (%)</th>
<th>Iron supplementation* n (%)</th>
<th>Haemoglobin (g/dl)</th>
<th>Ferritin (ng/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDA</td>
<td>16</td>
<td>27.0±1.2</td>
<td>9 (56.3)</td>
<td>5 (31.3)</td>
<td>10.3±0.2</td>
<td>3.5 (2.9~4.3)</td>
</tr>
<tr>
<td>NAID</td>
<td>28</td>
<td>29.4±0.9</td>
<td>19 (67.9)</td>
<td>2 (7.1)</td>
<td>11.8±0.1</td>
<td>3.5 (3.2~3.8)</td>
</tr>
<tr>
<td>NC</td>
<td>9</td>
<td>26.4±1.4</td>
<td>4 (44.4)</td>
<td>1 (11.1)</td>
<td>12.3±0.4</td>
<td>12.2 (9.5~15.6)</td>
</tr>
</tbody>
</table>

Significant difference NS NS NS NS P<0.01 P<0.01

Values are expressed as arithmetic means ± SE except for serum ferritin values which are expressed as geometric means ± SE range.

*Values indicate number of multipara or mothers who received therapeutic iron supplementation during pregnancy. Values in parentheses are percentages.

### Table 2

<table>
<thead>
<tr>
<th>Group</th>
<th>No.</th>
<th>Birth weight (g)</th>
<th>Haemoglobin (mg/dl)</th>
<th>Iron (µg/dl)</th>
<th>TIBC (µg/dl)</th>
<th>Ferritin (ng/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDA</td>
<td>16</td>
<td>3183±124</td>
<td>16.2±0.4</td>
<td>85.9±11.3</td>
<td>234.9±18.6</td>
<td>77.1 (64.6~92.0)</td>
</tr>
<tr>
<td>NAID</td>
<td>28</td>
<td>3119±66</td>
<td>15.8±0.3</td>
<td>76.7±9.3</td>
<td>245.0±13.2</td>
<td>81.5 (69.2~95.9)</td>
</tr>
<tr>
<td>NC</td>
<td>9</td>
<td>2962±146</td>
<td>16.4±0.7</td>
<td>109±12.9</td>
<td>242.0±34.2</td>
<td>90.1 (75.5~107.6)</td>
</tr>
</tbody>
</table>

Significant difference NS NS NS NS NS P<0.01

Values are expressed as arithmetic means ± SE except for serum ferritin values which are expressed as geometric means ± SE range.
among the newborns of mothers with different iron status.

With regard to serum ferritin, active iron transfer results in higher ferritin concentration in cord blood compared to that in maternal plasma. The ratio of cord blood plasma ferritin and maternal plasma ferritin concentrations (C/M ratio) seems a good index of unidirectional active process in materno-foetal transport of iron. In iron repleted mother who had prophylactic iron supplementation during pregnancy, C/M ratio was calculated as 5.0 (Table 3). In our study, particularly in IDA and NAID groups, C/M ratio was higher than that in iron-replete mothers suggestive of more active iron transport for compensation. On the other hand, it is presented that the level of cord blood plasma ferritin is low in moderate or severe anaemic mother. Active iron transport appears not able to compensate deficient iron in moderate or severe anaemic mother.

With regard to the iron stores of newborns, several studies have been done on serum ferritin levels. Rios et al. reported that there was no significant difference in serum ferritin levels between infants of iron-depleted and non-iron depleted mothers. Kelly and Macdonald also observed a significantly lower concentration of ferritin in cord serum when the maternal ferritin value was less than 10 ng/ml than those associated with maternal serum ferritin greater than 30 ng/ml. Although there were no iron replete mothers in our subjects, the levels of serum ferritin were significantly different among newborns with different maternal iron status. Based on these findings and that of other investigators we can speculate that mild maternal iron deficiency and non-anaemic iron deficiency will affect the iron stores of newborns.

All term infants are assumed to have sufficient iron during the first 3 months as most of the total body iron is contained within the circulating haemoglobin. After 3 months of age iron stores are usually mobilized to meet the erythropoietic demands of an expanding total haemoglobin mass because breastmilk is not sufficient to meet the demands of growth. As a result the level of plasma ferritin declines. Infants with small iron stores will deplete iron earlier than iron replete infants.

### Table 3

<table>
<thead>
<tr>
<th>Group</th>
<th>C/M ratio</th>
<th>Significant difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDA</td>
<td>29.2 ± 2.1</td>
<td></td>
</tr>
<tr>
<td>NAID</td>
<td>30.7 ± 3.8</td>
<td>P &lt; 0.05</td>
</tr>
<tr>
<td>NC</td>
<td>10.2 ± 2.5</td>
<td></td>
</tr>
<tr>
<td>Iron repleted mother*</td>
<td>5.0</td>
<td></td>
</tr>
</tbody>
</table>

Values are expressed as arithmetic means ± SE.

*C/M ratio was calculated from the data of reference.*

References